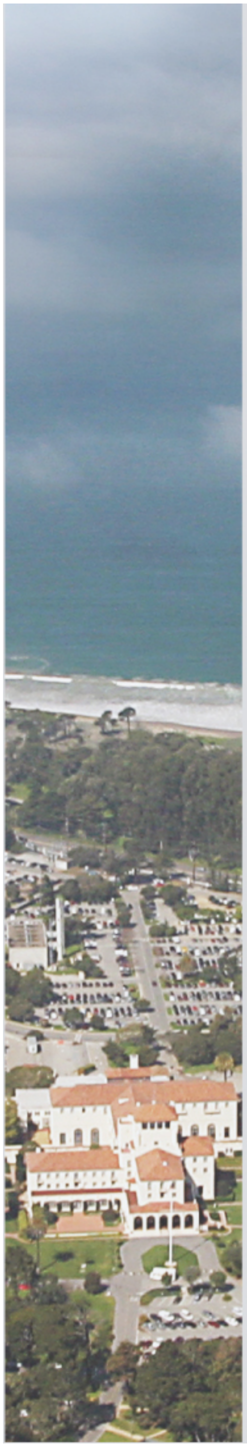

Naval Postgraduate School
Center for Information Systems Security Studies and Research

Assurance Considerations for a Highly Robust TOE

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Discussion Topics

- TOE overview
  - Separation Kernel (SK)
  - Separation Kernel Protection Profile (SKPP)
- Assurance issues for High Robustness
  - Platform Assurance
  - Trusted Initialization
  - Trusted Recovery
- SKPP extended requirements
- Conclusion and plans

Separation Kernel

- Introduced by Rushby (1981)
- Simpler than traditional security kernels
- Primary functional properties
  - Separate system resources into ***security policy equivalence classes***, i.e., ***partitions***
  - Control information flows between and within partitions
- ***Configuration data*** establishes
  - Binding of resources to partitions
  - Policy rules for information flow control
- No support for MAC labels but can be configured to control information flows in a manner consistent with a MLS policy

Least Privilege Separation Kernel

- Refinement of separation kernel
- Apply Principle of Least Privilege to further restrict access to resources
  - Basic SK: homogeneous resource-access requirements
    - Same access authorizations for all subjects in a partition
  - Least Privilege SK: heterogeneous resource-access requirements
    - Separate access authorizations for different subjects in a partition

High Robustness

- **Robustness – US scheme only**
  - Metric for TOE's protection ability
  - Degrees of robustness: Basic, Medium, High
    - Assurance level
    - Strength of security functions
- **Robustness requirement for a TOE**
  - Based on value of data and threats in operational environment
- **High robustness**
  - Provides most stringent protection
  - Can counter sophisticated, well-funded attacks
  - Suitable to protect high value data

Separation Kernel Protection Profile

- U.S. Government Protection Profile for Separation Kernels in Environments Requiring High Robustness
  - Validated in July 2007 (Version 1.03, 29 June 2007)
- Based on Common Criteria Version 2.3
- Assurance requirements
  - Combination of CC-defined components for EAL6 and EAL7
  - Two types of explicitly stated components
    - Modifications of existing CC requirements
    - New requirements

→ No EAL claim due to these extensions

Security Concepts in SKPP

- Enforcement of Partition Information Flow Policy
  – Partition Abstraction, Least Privilege Abstraction
- TOE configuration change
  – Four models: offline, static, constrained, unconstrained
- Establishment of initial secure state
  – Achieved through different degrees of assurance levied on non-TSF components
    - Delivery mechanisms
    - Configuration data generation capability
    - TOE loader
    - Initialization mechanisms
- Trusted recovery
- Platform assurance

Assurance Issues for High Robustness

Platform Assurance

Trusted Initialization

Trusted Recovery

Platform Assurance Issues

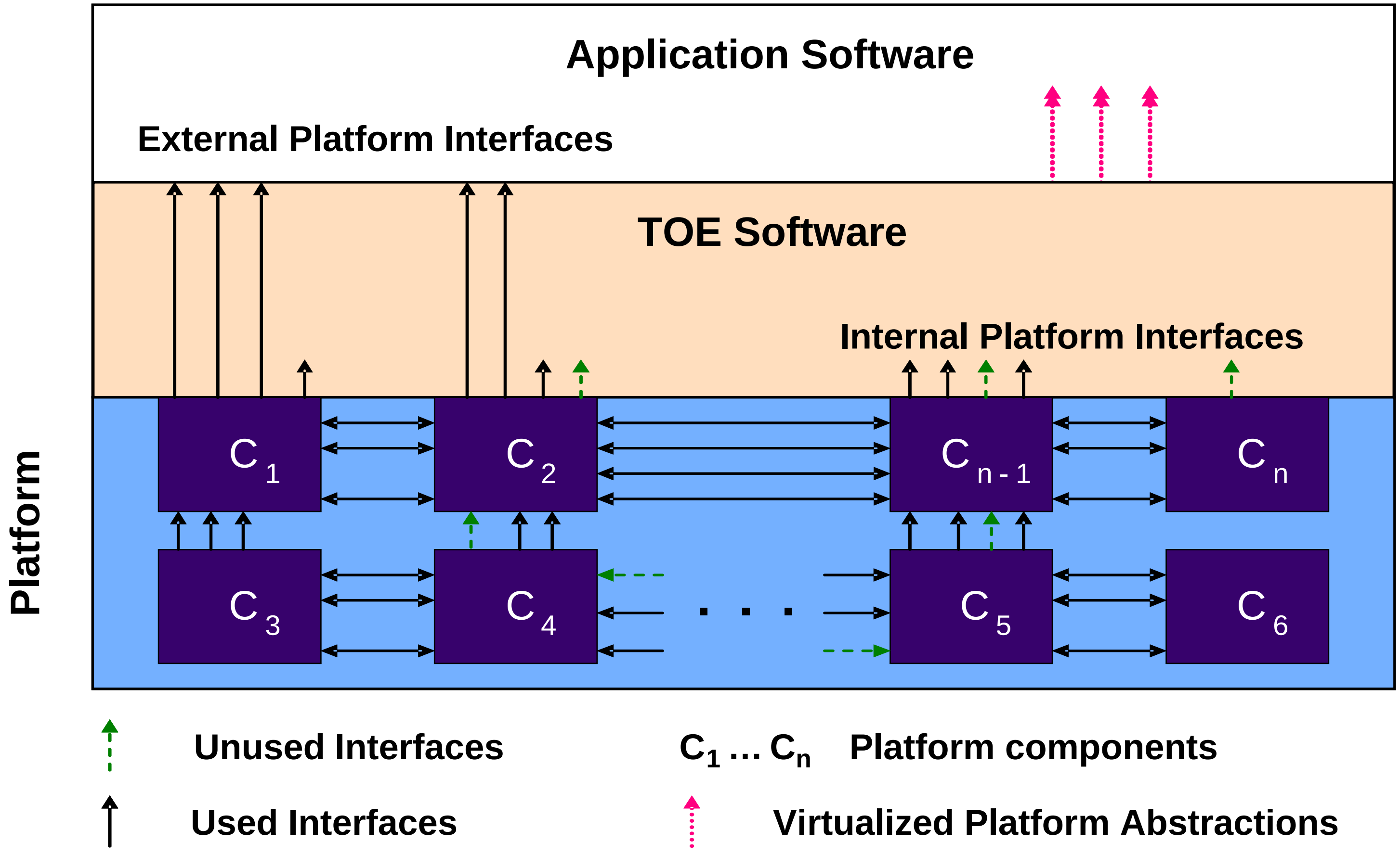
- High robustness requires hardware-supported domain separation and self-protection mechanisms
- No CC-defined requirements for hardware assurance
- Difficult to produce assurance evidence for hardware at same level of detail as software
- Need an assurance framework
  - To assess security properties of hardware mechanisms based on their interfaces to software
  - To establish trust in security-relevant hardware mechanisms
  - To address hardware obsolescence during and after TOE evaluation

→ New Class APT -- Platform Assurance

Platform Concepts

- **Platform = hardware + associated firmware**
- **Platform component**
  - Independently procurable, mass-produced, non-specialized
- **TOE platform = one or more platform components**
  - Defined by ST author
- **Platform definition can vary based on intended usage of the TOE**
  - Very restrictive: require a specific component type with exact properties
  - Less restrictive: allow variations in properties of a specific component type
  - More open: allow use of different component types with defined assembly rules
- **Platform interface**
  - Internal: accessible only to TOE components
  - External: accessible to both TOE components and entities outside the TOE

Hardware/Software Relationships



Trusted Initialization Issues

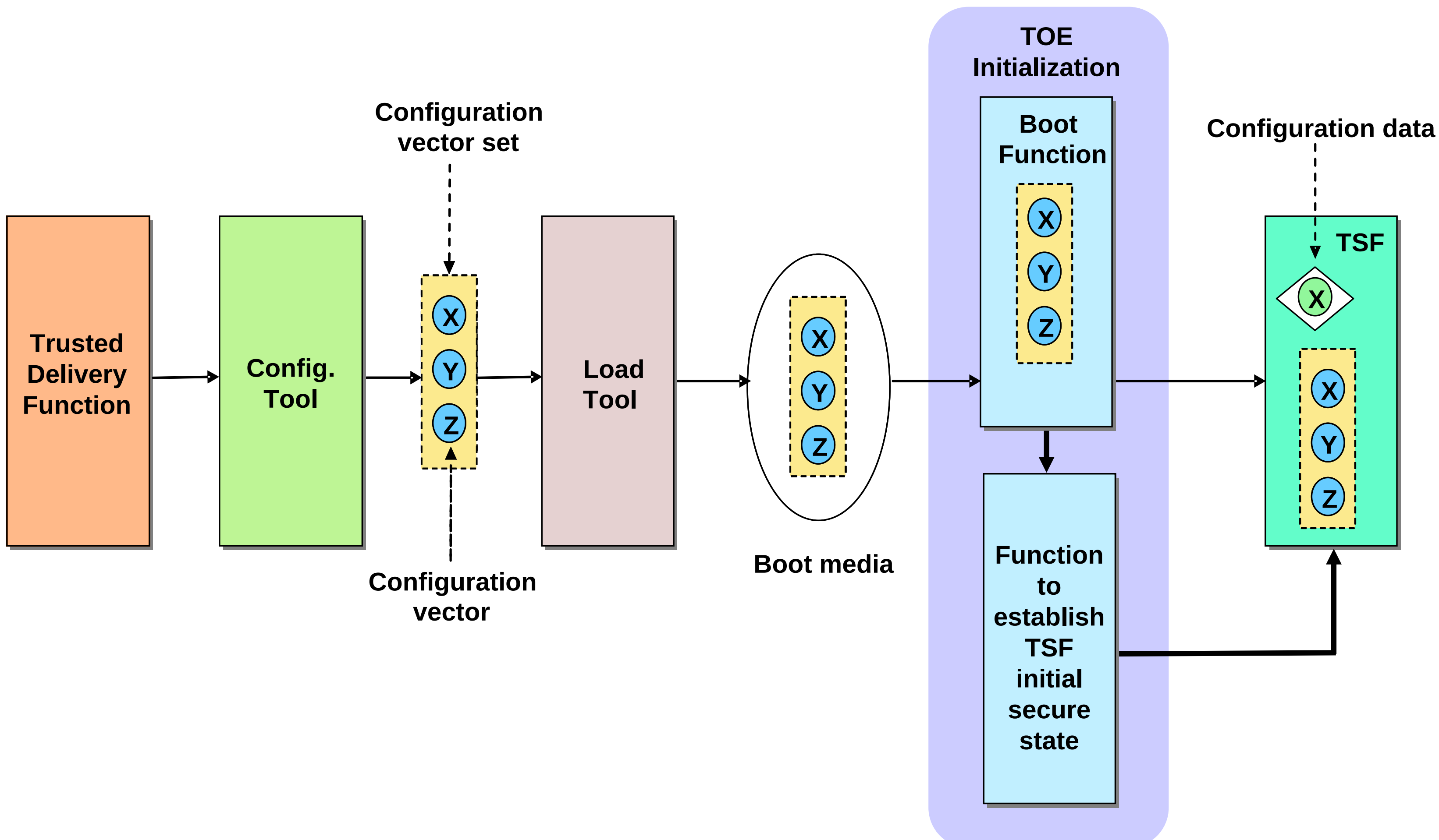
- CC Version 2.x defines no requirements for TOE initialization
  - Rely on administrative actions to ensure proper TOE initialization
- Intended usage of SK requires autonomous TOE initialization
- TSF cannot initialize itself
  - Formal model assumes TSF starts in an initial secure state
- Need a robust mechanism to
  - Establish execution environment for the TSF
  - Bring the TSF to an initial secure state defined by configuration data
- Generation and loading of configuration data need commensurable assurance

SKPP Approach to TOE Initialization

- Correct TOE initialization is achieved through a trust chain of non-TSF functions
  - Delivery
  - Configuration data generation
  - TOE loading
  - Initialization
- Require use of standardized cryptographic algorithms for trusted delivery
  - American National Standards Institute (ANSI)
  - National Institute Standards and Technology (NIST)
- Apply different developmental assurance measures to other initialization-related functions

$\longrightarrow$ New assurance ADV families

TOE Components



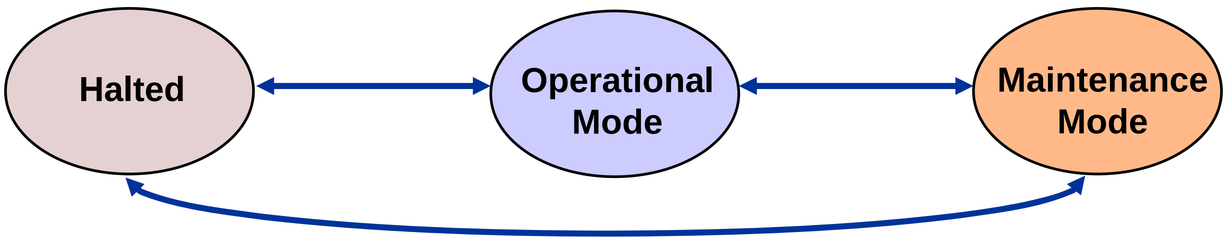
Trusted Recovery Issues

- CC requirements emphasize ways to handle failures and discontinuities
  - Manual versus automated
- CC is vague about presence of recovery functions while in maintenance mode
  - "In the maintenance mode, normal operation might be impossible or severely restricted, as otherwise insecure situations might occur."
- Verification of robustness of recovery mechanisms is difficult
  - Failures/discontinuities have no formal properties

SKPP Approach to Trusted Recovery

- **Focus on protecting the TSF against further compromise during a recovery**
- **Extend FPT_RCV to require the TSF to attempt recovery to a secure state upon detection of an insecure state**
- **Expand definition of maintenance mode**
  - "A contiguous period during an execution session when operational mode functions are restricted, <u>or recovery functions are available that are not available during operational mode, or both</u>."
- **Clarify intended use of maintenance mode**
  - Enable the TOE to return to a secure state
  - Prevent the TOE from entering an insecure state

Maintenance Mode & Secure State



	STATE / MODE	Secure (S)	Insecure (I)
Execution Session	Operational (O)	O\S	O\I
	Maintenance (M)	M\S	M\I
Halted (H)		H\S	n/a

SKPP Extended Requirements

Platform Assurance (APT)

- New assurance class with five families
  - Platform Definition (APT_PDF)
  - Platform Specification (APT_PSP)
  - Platform Conformance Testing (APT_PCT)
  - Platform Security Testing (APT_PST)
  - Platform Vulnerability Assessment (APT_PVA)
- Focus on specifications instead of identifications of components
- Replace a subset of ADV, ATE and AVA requirements for COTS components
  - Specialized components by TOE developer must meet all ADV, ATE and AVA requirements defined for software
- ACM, ADO_DEL and ALC requirements only apply to specialized components
  - Information about CM, delivery, development security are not generally available for COTS components
- Does not address physical protection and anti-tampering issues

Platform Definition (APT_PDF)

- Require Platform Definition Document (PDD) to support component-specific security analysis against SFRs
- PDD can include vendor documentation if they meet content requirements
- PDD include
  - Component types and assembly rules
  - Identification of component interface specifications for all interfaces
  - Security analysis on how each component type interacts with the TOE
  - Precise references to component interfaces so that specifications can be obtained by third-party

Platform Specification (APT_PSP)

- Require complete specifications of platform component interfaces
  - External interface
  - Internal interface
  - Unused interface
- Specifications include
  - Invocation methods, parameters, expected results, error conditions
  - Arguments that all interfaces are included in specifications
- Support functional analysis and vulnerability assessment of the TOE

Platform Conformance Testing (APT_PCT)

- Require functional testing to ensure platform components identified in PDD operate as expected
  - Vendor-provided tests may be used to satisfy this requirement
- Require exercising all security features that are relied upon by the TSF
  - Testing is performed through TSF interfaces
  - Tests are to be developed by TOE developer

Platform Security Testing (APT_PST)

- Require comprehensive security testing
  - Verify correct operations of all external and internal platform interfaces
- Tests to be performed at the component interface level
  - Different than tests in APT_PCT which are at TSF interface level
- Test documentation include
  - Procedures and expected results
  - Argument that test coverage is complete

Platform Vulnerability Assessment (APT_PVA)

- Performed as part of TOE vulnerability analysis
- Assessment is at platform interface level
  - All external platform interfaces
  - All internal platform interfaces used by the TOE
- Complement AVA_VLA requirements
  - Systematic search for vulnerabilities
  - Disposition of identified vulnerabilities
  - Justification that analysis is complete
  - Independent vulnerability analysis by NSA
  - Independent penetration testing by NSA

Trusted Initialization (ADV_INI)

- New family in Class ADV
- Levy both functional and assurance requirements on initialization function
  - Initialization has both testable behaviors and development process
  - SFR paradigm is not applicable to non-TSF components
- Functional responsibilities of initialization function
  - Establish the TSF in an initial secure state
  - Verify integrity of TSF code and data during initialization
  - Handle failures during initialization
  - Provide self-protection during initialization
  - No arbitrary interaction with the TSF after initialization
- Require cooperation from TSF to prevent rogue initialization function
  - Extended SFR requires secure state confirmation by TSF prior to TSP enforcement (FPT_ESS_EXP)

Development Assurance for Initialization

- **Architecture assurance**
  - Self-protection against tampering from other TOE components
  - No interaction with TSF operations after initialization
- **Functional specification**
  - Similar to ADV_FSP requirements for TSF
  - Describe each initialization interface
    - Purpose, method of use, parameters, operations, exceptions, error messages and effects
- **Design documentation**
  - One level of specification, i.e., not as rigorous as ADV_HLD and ADV_LLD for TSF
  - Require modular composition of components
  - Module characterization is based on relevancy to secure state establishment (SSE)
    - SSE-related, SSE-unrelated
- **Test documentation**
  - Test plan, test procedures, expected results, actual results

Configuration Tool Design (ADV_CTD)

- Configuration vector(s) define the initial secure state
  - Corrupted vector could result in unintended TSF operations
- Need robust Configuration Tool to generate and validate configuration vector(s)
- ADV_CTD levies both functional and assurance requirements on Configuration Tool
- Configuration Tool capabilities
  - Generate human-readable form of configuration vectors with clear semantics to allow validation of intended TOE configuration
  - Preserve semantics of data during conversion between human-readable and machine-readable forms of configuration vectors
  - Apply cryptographic seal(s) on generated configuration vector(s)
- Design documentation
  - Explain how to verify correctness and accuracy of generated configuration vector(s)
  - Same level of abstraction and detail required by ADV_HLD

Load Tool Design (ADV_LTD)

- Similar to ADV_CTD
  - Include both functional and assurance requirements
- TOE loading function needs to be robust
  - Part of the chain of trust to establish initial secure state
  - Must maintain integrity of TOE software and configuration vector(s)
- Load Tool capabilities
  - Convert TOE software and configuration vector(s) into a TOE-usable form
  - Preserve integrity of code and data during conversion
- Design documentation
  - Explain the conversion process
  - Same level of abstraction and detail required by ADV_HLD

Trusted Recovery (FPT_RCV)

- Extend base FPT_RCV.2 component
- TSF must attempt recovery to a secure state upon detection of being in an insecure state
  - After completion of TOE initialization
  - During execution session
- TSF must attempt to halt if unable to complete recovery action
  - Transition to maintenance mode may be an acceptable action for certain TOEs
- ST enumerates pair-wise recovery conditions and associated actions
  - Recovery is implementation-specific
- Require assurance evidence that secure state results from the identified action
  - TSF design specifications
  - Administrative guidance documentation
  - Test analysis documentation

Conclusion and plans

- **Assurance considerations for high robustness not sufficient as addressed in CC Version 2.3**
  - Platform assurance, trusted initialization, trusted recovery
- **SKPP explicitly defined SFRs and SARs to address these issues for a separation kernel TOE type**
- **Most of these extended requirements are applicable to other high assurance TOE types**
- **Next step for this PP development team**
  - Development of another high robustness PP for a more complex TOE
    - Leverage SKPP experience to shorten PP engineering time
  - Challenge is to articulate high robustness requirements in CC Version 3.1 context

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